Test Report V1.0

Single Event Testing of the 28VDC Solid-State Power Controller RP21005 from DDC

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1 Introduction

Single event effects (SEE) testing of the DDC RP21005 Solid State Power Controller from DDC was performed with heavy ions at Texas A&M Cyclotron Facility. This work was performed for the SDO project.

2 Tested Devices

Information about the tested devices is given in Table 1. The manufacturer provided two de-lidded devices for the tests. Fig 1 shows a picture of the de-lidded device. It is a hybrid, containing a number of active components. All the active components are located sufficiently far apart from one another that they cannot all be irradiated at the same time. Figure 1 shows the two areas that were irradiated.

Table 1: Description of the tested devices

Type	RP-21005DO-601P
Function	28VDC Solid State Power Controller
Package	Hermetic 1.34" x 2.74" x 0.325" steel package
Technology	Hybrid
Date Code	0418

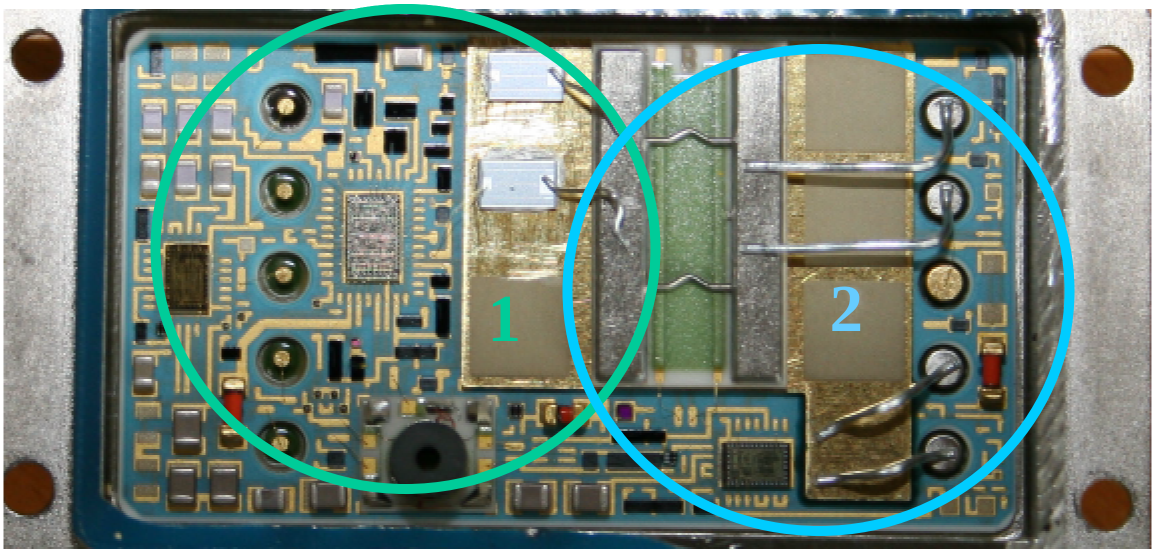

Fig 1: Picture of a de-lidded Solid Sate Power Controller and identification of the two irradiated areas.

3 Testing Description

3.1 Irradiation conditions

The tests were performed at TEXAS A&M with 15 MeV/u beams. The parts were irradiated in air. The ions used and their characteristics are described in Table 2. The LET and range values given in Table 2 are the LET and ranges on the DUT.

Table 2: Ions used at TEXAS A&M

Ion	**Energy (MeV/u)**	**Energy at target (MeV)**	**Range at target (? m)**	**LET at target (MeV-cm^2/mg)**
Xe	15	1215	96	54.4
Ne	15	270	267	2.75

3.2 Test set-up and bias conditions

The device bias supply voltage was set at 5V. The DUT was irradiated with the output switch in the on state (control input at high level). The DUT output switch bias conditions are listed in Table 3.Two output load conditions and two output voltage conditions were investigated.

Table 3: DUT output switch bias conditions

Output Voltage (V)	Output Load (%)	Output Load (A)
22	100	5
	20	1
34	100	5
	20	1

The output of the DUT was monitored with an oscilloscope. As soon as the DUT output exceeded a given trigger level set below the nominal value, the resulting waveform, termed a Single Event Transient (SET), was captured on the oscilloscope and subsequently stored on a PC.

4 Results

The results of the SEE testing are shown in Table 4. Only one part was tested because the other available part was not functional.

Table 4: test results

Run #	SN #	Voltage (V)	Load (A)	Area #	Ion	eff LET ($MeVcm^2/mg$)	eff. Fluence ($\#/cm^2$)	SET #	X SET (cm^2/dev)
131	2	34	5	1	Xe	76.9	9.92E+05	277	2.79E-04
132	2	34	5	1	Xe	76.9	1.09E+06	459	4.21E-04
133	2	34	5	1	Xe	54.4	7.12E+05	269	3.78E-04
134	2	34	5	2	Xe	54.4	5.22E+06	0	0.00E+00
135	2	22	5	1	Xe	54.4	1.13E+06	363	3.21E-04
199	2	34	5	1	Ne	3.9	6.56E+06	>8	
200	2	34	5	1	Ne	3.9	1.22E+05	1	8.20E-06
201	2	22	5	1	Ne	3.9	2.31E+05	1	4.33E-06
203	2	22	5	1	Ne	3.9	2.44E+05	1	4.10E-06
204	2	22	5	1	Ne	2.8	2.02E+06	6	2.97E-06
205	2	22	1	1	Ne	2.8	2.12E+05	1	4.72E-06
206	2	22	1	1	Ne	2.8	3.30E+05	1	3.03E-06
207	2	22	1	1	Ne	2.8	2.80E+05	1	3.57E-06

A summary of the results is as follows:

?? When area 1 is irradiated, the device is extremely sensitive to SET, and the switch may be turned off very easily. When the switch is turned off, it is generally coming back to the on state, but in some cases it does not comes back to the on state. When the switch is turned off, the control input should go back to the low level and then to the high level to turn the switch on again. Typical transient waveforms are shown in Figures 2 to 4.

?? When area 2 is irradiated the device is not sensitive to SET, and the output switch stays in the on state.

?? No destructive event was observed up to the maximum LET of 77 $MeVcm^2/mg$.

?? No significant effect of the output voltage or load condition was observed.

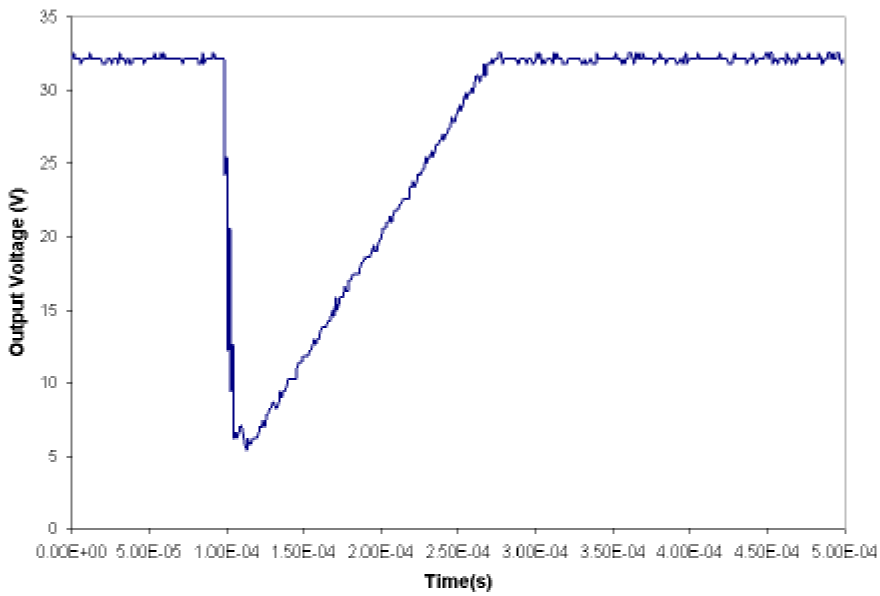

Fig 2: typical short duration transient, run 133, frame 0

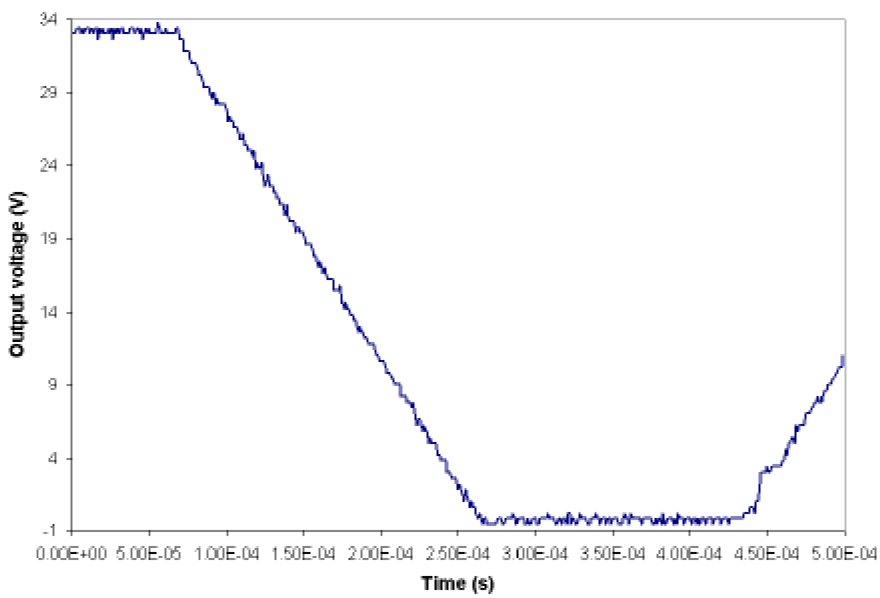

Fig 3: typical long duration transient, run 133, frame 73

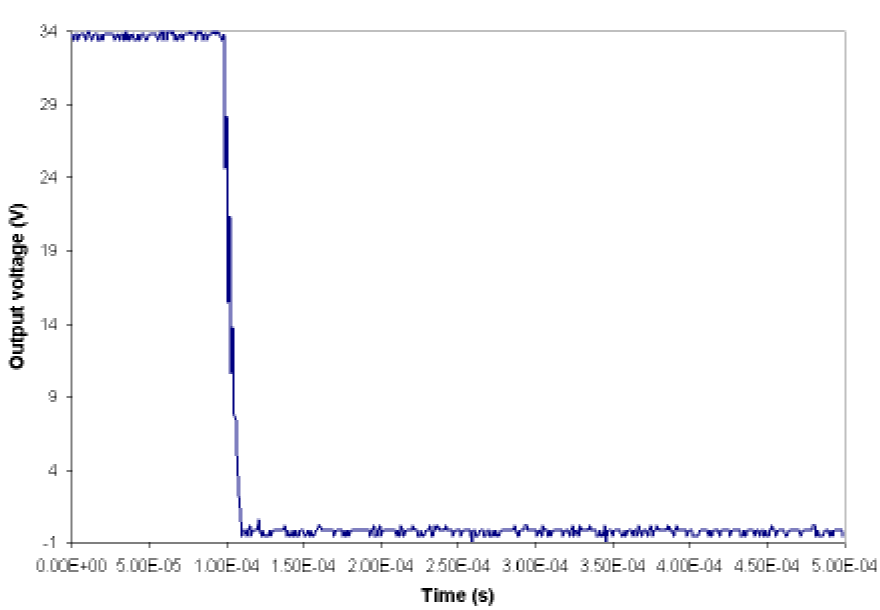

Fig 4: Example of a very long transient, run133 frame 31

Fig 6 shows the device SET cross section curve. The LET threshold is lower than 2.8 $MeVcm^2/mg$ and the cross section at the highest LET is about 4E-4 cm^2/device.

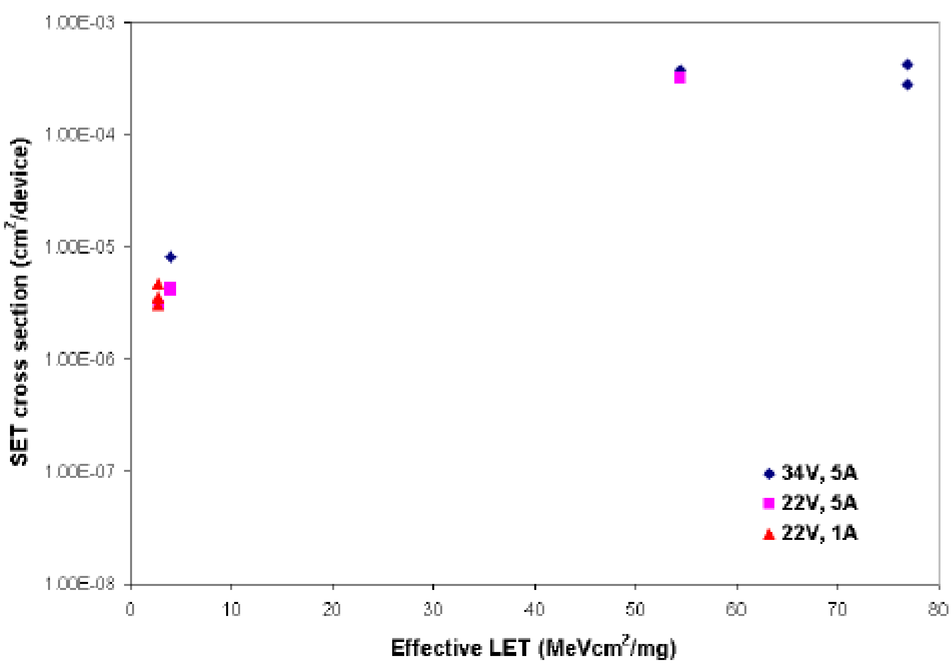

Fig 2: SET cross section curve

5 Conclusions

The salient results obtained from this testing are:

- No destructive condition was observed during all tests.
- The SET sensitivity is extremely high with a LET threshold as low as 2.8 $MeVcm^2/mg$. In some cases, the output switch is permanently turned off.

In general, devices are categorized based on heavy ion test data into one of the four following categories:

Category 1 – Recommended for usage in all NASA/GSFC spaceflight applications.
Category 2 – Recommended for usage in NASA/GSFC spaceflight applications, but may require mitigation techniques.
Category 3 – Recommended for usage in some NASA/GSFC spaceflight applications, but requires extensive mitigation techniques or hard failure recovery mode.
Category 4 – Not recommended for usage in any NASA/GSFC spaceflight applications.

Based on heavy ion data and the device function, this part is assigned to category 4.